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AIRMUNITIONS TEST REPORT

SHELF LIFE TEST
ON
ROCKET MOTORS,
15-KS-1000, MK 6 MODS





SHELF LIFE TEST

ON

ROCKET MOTORS, 15-KS-1000, MK 6 MODS

by

Røbert M. Cavett

PUBLICATION REVIEW

This report has been reviewed and is approved

ALEX B. PERESICH

Chief,

Engineering and Test Division 2705th Airmunitions Wing

Peresich

FEBRUARY 1963

2705TH AIRMUNITIONS WING OGDEN AIR MATERIEL AREA AIR FORCE LOGISTICS COMMAND UNITED STATES AIR FORCE Hill Air Force Base, Utah

NOTICES

The information furnished herewith is made available for study with the understanding that the Government's proprietary interests in and relation thereto shall not be impaired. It is desired that the Judge Advocate's Office, WCJ, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio, be promptly motified of any apparent conflict between the Government's proprietary interests and those of others.

The conclusions and recommendations made in this report are not to be considered directive in nature. This type information becomes official only when published in Technical Orders or other applicable Air Force publications.

ADMINISTRATIVE DATA

PURPOSE OF TEST:

This test was to verify the existing nine year shelf life and determine if any extension is possible.

MANUFACTURER:

Aerojet General Corporation, Azusa, California

MANUFACTURER'S TYPE OR MODEL DESIGNATION:

MOTOR: Rocket Motor, 15-KS-1000, Mk 6 Mods (FSN 1340-309-5092-H340)

IGNITER: Igniter for 15-KS-1000 Rocket Motor, Mk 165 (FSN 1340-309-5095-H403)

DRAWINGS AND SPECIFICATIONS:

Specification ATS-S2.109 Aerojet-General Corporation Igniter Drawing 39415 Aerojet-General Corp Igniter Specification ATP-SA-10I.005k Aerojet-General Motor Drawing 39060 Aerojet-General Corp

QUANTITY OF ITEMS TESTED:

24 each motors and igniters

SECURITY CLASSIFICATION:

Unclassified

TESTS CONDUCTED BY:

OOAMA (OOYET - 2705th Airmunitions Wing)

Tust Director: Hoyt O. Brown, Major, USAF

Project Engineer: Robert M. Cavett, Chemical Engineer

DISPOSITION OF SPECIMENS:

All metal parts generated from this operation were inspected, certified inert and turned over to the Redistribution and Marketing Division in accordance with Technical Order 11C3-1-3 and HAFBR 136-2.

ABSTRACT

This investigation was one phase of a series established to determine the ultimate life of the 15-KS-1000 Rocket Motor. To accomplish this, 24 motors were visually and radiographically inspected and fired using static facilities at Hill Air Force Base, Utah. In order to best evaluate serviceability, temperature conditioning was accomplished at both high and low extremes of 150°F and -75°F.

The motors, as in the past, continued to function without incident. Some small drift of the data from normality toward the specifications limits was noted but was not significantly detrimental to effect serviceability. The previous established life of 9 years was confirmed and an extension to 10 years is recommended.

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INTRODUCTION

A total of 120 15-KS-1000 Rocket Motors were initially reserved for shelf life testing purposes. These units were stored at Eielson Air Force Base, Alaska until 1959, at which time they were shipped to Hill AF Base, Utah. Prior to this test, the established shelf life of 5 years had been extended, by previous test, to nine years. This test is the latest phase in determining the maximum life of this motor.

The tests were accomplished in accordance with OOYEE Test Directive C-1-509-Y-2, 11 April 1961 and OOYEG SOP C-1-509-Y-2, 18 April 1962. Any inquiries on this report should be addressed to the Ground Launch Missiles Branch (OOYEG), Engineering and Test Division (OOYE), 2705th Airmunitions Wing (OOY). This document is the final report for Project C-1-509-Y-2.

DESCRIPTION

The 15-KS-1000 Rocket Motor consists of a chamber assembly and an Aft-cap assembly which contains an outside restricted, internal burning, slotted propellant grain. The various components and dimensions of the motor are shown in Figures 1 and 2.

Principle data on motor manufacture are as follows:

Rocket Motor:

Overall Length (Avg)	33.45 Inches
Diameter (Principal)	10.30 Inches
Diameter (Maximum)	11.45 Inches
Weight (Avg):	
Loaded	144 Pounds
Expended	72 Pounds

Design Safety Data of the 15-KS-1000 Rocket Motor:

Temperature range	-65° F to 140° F
Ultimate strength of chamber	2400 psi
Operating pressure range	447 to 735 psi
Pressure-release diaphragm range	1200 to 1600 psi
Allowable acceleration along axis	18 g
Allowable acceleration normal to axis	12 g

Propellant Grain Manufacture:

Type Aeroplex AN-583AF

Manufacture method Cast

Grain Design Slotted, Internal Burning

Propellant Grain Dimensions:

Length 26.5 Inches
Diameter 9.7 Inches
Web Thickness 3.4 Inches

Propellant Composition (% by weight) is classified Confidential, therefore it has been omitted from this report. It can be found in OOYEE Confidential Report OOY-TR-61-11, February 1961 or in the Solid Propellant Information Agency Manual. M-1

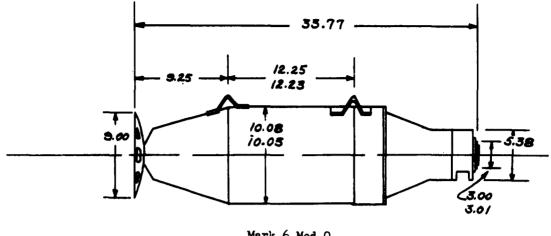
The igniter used with the 15-KS-1000 Rocket Motor is the Mk 165 which is also manufactured by the Aerojet-General Corporation. The electrical characteristics of the Mk 165 Igniter are:

Resistance $0.25 (\pm 0.06)$ ohm

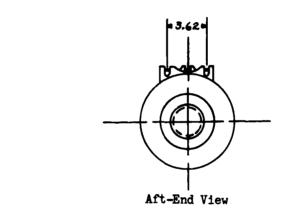
Recommended Firing Current 25 amp

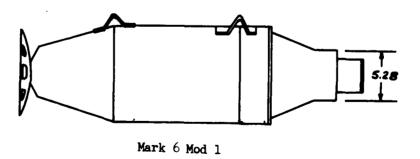
Maximum No-Fire Current 0.04 amp

The Mk 165 Igniter uses a glow plug to ignite a charge of black powder which in turn ignites the main charge of alclo pellets. The internal configuration of the Mk 165 Igniter is shown in Figure 3.



Mark 6 Mod 0





All Dimensions are in Inches

External Dimensions of the Rocket Motor, 15-KS-1000 FIGURE 1.

LEGEND for FIGURE 2

- 1 Nozzle
- (2) Pressure Release Diaphragm
- (3) Safety Diaphragm Deflector Cone
- (4) Retainer Ring

4

5 Aft-Cap Assembly

- (6) Propellant Grain
- 7 Mounting Lugs
- (8) Insulating Boot
- (9) Chamber Assembly
- (10) Handling Stand

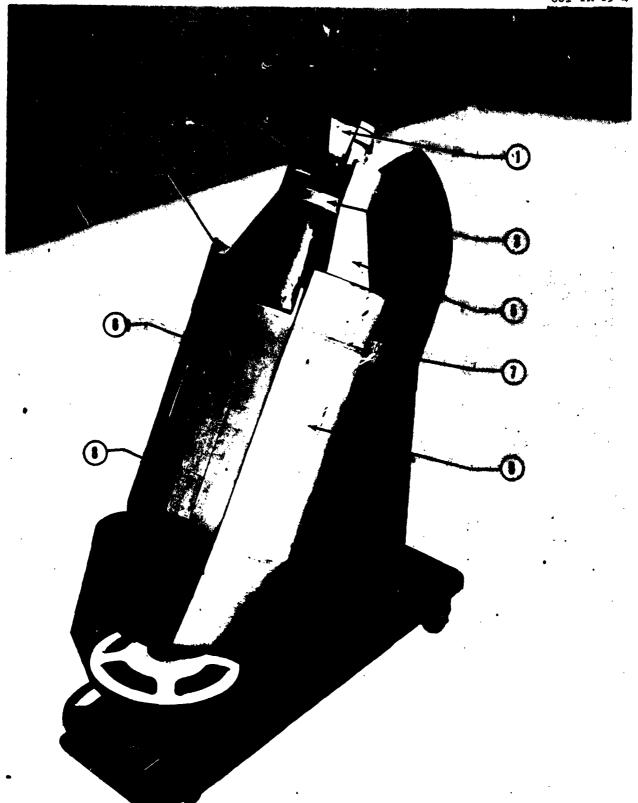


FIGURE 2. Cutaway View of a 15-KS-1000 Rocket Motor Showing its Major Components.

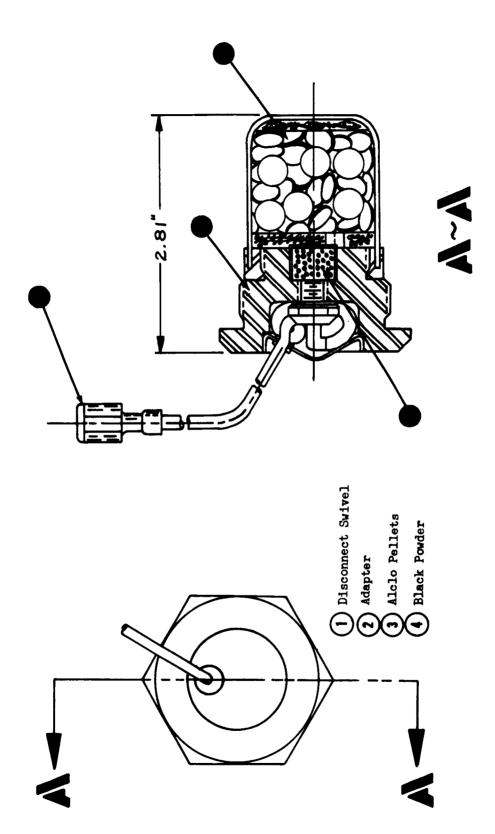


FIGURE 3. The Mark 165 Igniter Showing Its Internal Configuration.

TEST PROCEDURES

Twenty-four 15-KS-1000 Rocket Motors were visually and radiographically inspected. Five motors were disassembled and a thorough internal inspection performed. Ten motors were temperature conditioned to -75°F, four to 70°F and ten to 150°F. All were fired and the results evaluated. The equipment used for the static firings are shown in Figure 4.

TEST RESULTS

VISUAL INSPECTION

The visual inspection, both internal and external, was accomplished with no defects found. The five motors which were disassembled were in excellent condition. These motors were reassembled and fired with the others.

RADIOGRAPHIC INSPECTION

Each motor was X-rayed in two positions with a 2MEV unit. The defects (voids) found are listed in Table 1. These voids are normal in size and quantity for this motor and have never been known to produce adverse results during static tests.

IGNITER CHECK

All igniters were examined and tested for continuity prior to conditioning. Seven of the 24 igniters had high resistances by from 0.03 to 0.26 ohm. These slightly high values had no effect on motor performance. All others were within allowable limits.

MOTOR		FOREWARD END		CENTER SECTION		AFT END
NO.	QTY	inches	QTY	INCHES	QTY	INCHES
1			1	.125 X .125	1	.125 X .125
2			1	.5 X .5		
			, 2	.125 X .125		
3			3	.25 X .25	L	
5		30 Scattered Voids		.25 X .25		.125 X .125
6	5	.25 X .25		.125 X .125		
7			1	.25 X .25	1	.125 X .125
8			1	.25 X .25	3	.125 X .125
9			1	.5 X.5	3	.125 X .125
			5	.25 X .25		
10	1	.75 X .75	1	.125 X .125	2	.125 X .125
11					2	.125 X .125
12					2	.25 X .25
13			3	.25 X .25	2	.125 X .125
15			1	.25 X .25	2	.25 X .25
17			1	.5 X .5		
			2	.125 X .125		
18	1_	.125 X .125	2	.25 X .25	1	.125 X .125
19			1	.25 X .25		
			1	.125 X .125		
20					1	.125 X .125
21	1	.25 X .25	1	.125 X .125	1	.125 X .125
22			1	.125 X .125	1	.5 X .5
					1	.125 X .125
23					1	.5 X .5
24	1_	.5 X .5	1	.5 X .5	2	.125 X .125

All defects are internal voids.

TABLE 1. Results of Radiographic Inspection.



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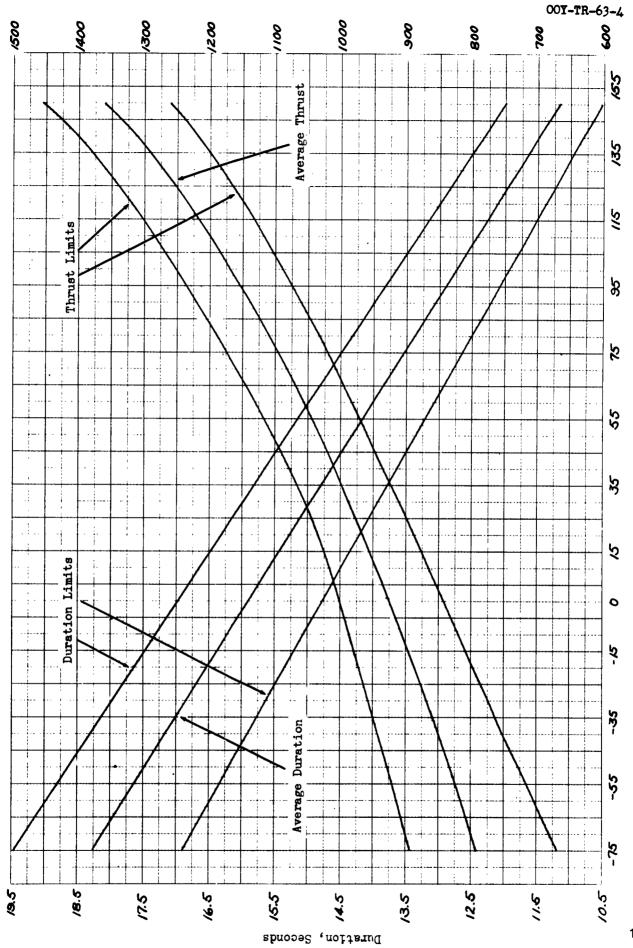
A graphical representation of the 15-KS-1000 performance specifications is shown in Figure 5. This data is also in numerical form in Table 2.

PARAMETERS	-75°F	70°F	150 ⁰ F
Duration, Maximum (Sec)	19.45	14.65	12.0
Duration, Nominal (Sec)	18.3	13.7	11.2
Duration, Minimum (Sec)	16.9	12.8	10.55
Thrust, Maximum (Lb)	890	1160	1460
Thrust, Nominal (Lb)	790	1080	1360
Thrust, Minimum (Lb)	670	1010	1260

TABLE 2. Specification Data for Rocket Motors, 15-KS-1000.

STATIC FIRING.

All 24 test motors were fired without malfunction. Thrust and duration data were all within specification limits. Pressure and impulse data were satisfactory and all ignition delays were within the 0.5 second maximum allowable. A graphical comparison of test data with specification limits is shown in Figures 6 and 7. Data on motor manufacture and performance is outlined in Tables 3 and 4. A statistical evaluation of the data is covered in Table 5.

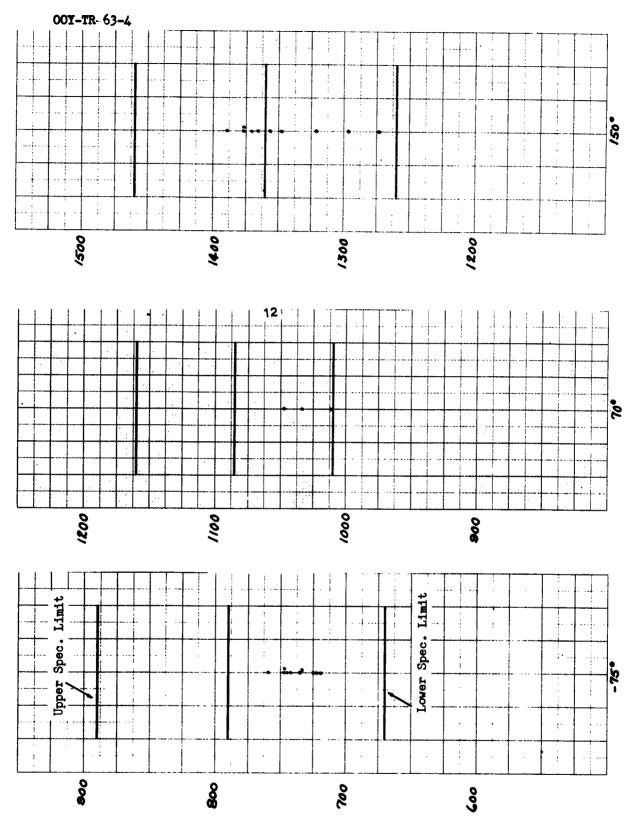


Performance Specification for the 15-KS-1000 Rocket Motor

FIGURE 5.

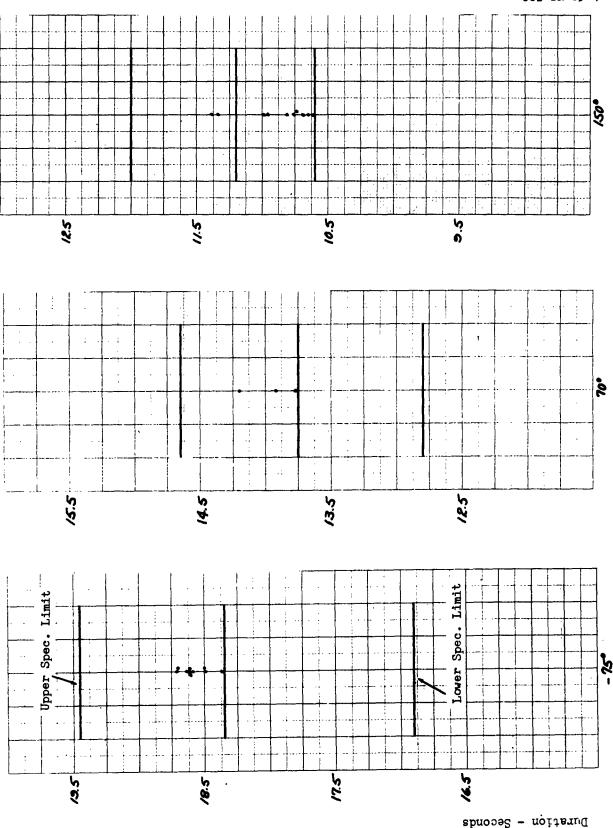
Temperature, OF

11



Thrust vs Temperature for 15-KS-1000 Rocket Motors, age 107 months FIGURE 6. Temperature - OF

Thrust - Pounds



13

Duration vs Temperature for15-KS-1000 Rocket Motor, age 107 months

FIGURE 7.

Temperature - OF

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MOTOR BATCH NO.	MOTOR NO.	TEMP (°F)	MOTOR MFG. DATE	ICNITER MFG. DATE	IGNITER RESIST. (1)	WEIGHT LOADED (LB)	WT. EMPTY (LB)	PROP. WT. (LB)
1-287	8	-75	5- 5 3	8-54	0.25	137	64	73
1-287	10	-75	5 - 5 3	8-54	0.24	137	64	73
1-307	11	- 75	5-53	8-54	0.56	137	64	73
1-287	13	-75	5 -53	8-54	0.24	136	63	73
1-307	14	- 75	5 - 5 3	8-54	0.34	137	63	74
1-287	15	- 75	5-53	8-54	0.23	136	63	73
1-307	16	- 75	5-53	8-54	0.37	137	63	74
1-287	17	-75	5 - 53	8-54	0.21	136	62	74
1-287	18	- 75	5-53	8-54	0.57	136	63	73
1-287	19	- 75	5-53	8-54	0.23	137	64	73
1-287	3	70	5-53	8-54	0.24	136	63	73
1-307	4	70	5-53	8-54	0.29	137	64	73
1-287	6	70	5- 53	8-54	0.24	136	63	73
1-287	12	70	5 - 53	8-54	0.26	1 3 6	63	73
1-287	1	150	5-53	8-54	0.25	137	64	73
1-287	2	150	5-53	8-54	0.27	136	63	73
1-287	5	150	5-53	8-54	0.36	136	64	72
1-287	7	150	5-53	8-54	0.21	136	63	73
1-287	9	150	5-53	8-54	0.24	137	64	73
1-287	2 0	150	5 -53	8-54	0.36	136	63	73
1-287	21	150	5-53	8-54	0.26	137	64	73
1-287	22	150	5-53	8-54	0.37	137	64	73
1-287	23	150	5-53	8- 54	0.25	137	63	74
1-287	24	150	5-53	8-54	0.30	137	63	74

TABLE 3. Manufacture Data.

DEFINITION OF PARAMETERS

IGNITION DELAY (TA)

Ignition delay is the time interval between fire switch and the point at which thrust reaches 250 pounds.

DURATION OF EFFECTIVE TIME (T.

The duration or effective time is the interval beginning when the thrust has risen to 250 pounds and ending when it has decreased to 250 pounds.

EFFECTIVE THRUST (F.

The effective thrust is the integral of the area under the thrust-time curve for the time period known as duration divided by the duration.

EFFECTIVE PRESSURE (P.

The effective pressure is the integral of the area under the pressure-time curve for the time period known as duration divided by the duration.

TOTAL IMPULSE (I.

The total impulse is the integral of the area under the thrust-time curve for the time period known as duration.

_	Τ			T	T .		Τ.	Т	1	γ	_		_	_	_	_				_		_	_	_	_	_	-0, -
		NO.I	16.90	16.90	16.90	16.90	16.90	16.9	16.90	16.90		16.9	12.80	12.80	12.80	12.80	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55	
TS	(T _e)	æ	18.30	18.30	18.30	18.30	18.30	18.30	18.30	18.30	8	18.30	13.70	8	8	3.70	1.20	8	1.20	1.20	8	•	•	+	11.20	11.20	
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SPECIFICATION	(Fe)	HICH NORM LOW	9 064	9 062	9 064	9 06/	9 064	L	9 062	9 064	<u> </u>	9 064	30 1010		-	30 1010	50 1260		50 1260	360 12	360 1260		360 1260	50 1260	50 1260	50 1260	ł
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_	HE	H	890	890	8	890	068	89	890	890	890	890	1160	1160	1160	1160	1460	1460	1460	1460	1460	0971	1460	1460	1460	1460	
SE	ďsI	(Lb.Sec/Lb)	190	189	187	191	183	189	183	188	189	184	*	198	161	197	199	30 0	205	203	202	202	198	199	200	199	
IMPLUSE	I	(Lb.Sec)	13859	13772	13467	13940	13554	13810	13571	13918	13832	13440	*	14429	14364	14386	14500	14620	14766	14804	14777	14772	14440	14543	14821	14728	
JST	Fe	(TP)	746	736	723	426	725	177	734	747	273	722	*	1048	1012	1033	1322	1377	1366	1348	1389	1297	1273	1362	1377	1371	
THRUST	$\mathbf{F}_{\mathbf{m}}$	(TP)	891	891	875	875	891	875	206	168	098	891	*	1266	1172	1235	1610	1672	1657	1610	1688	1641	1532	1672	1672 1377	1641	
URE	Ъ	(Ps1)	413	416	517	756	414	413	917	617	617	917	*	*	*	562	727	755	739	719	752	700	706	751	737	750	
PRESSURE	ш _а	(Psi)	767	767	167	167	167	<i>L</i> 67	203	167	8/7	507	*	*	*	675	891	910	8	863	910	882	835	910	8	891	ata.
31	T	(Sec)	18.59	18.71	18.63	18.37	18.70	18.49	18.50	18.62	18.61	18.62	*	13.77	14.20	13.92	10.97	10.62	10.81	10.98	10.64	11.39	11.34	10.68	10.76	10.74	ance D
TIME	$\mathbf{p}_{\mathbf{I}}$	(Sec)	0.31	0.43	0.29	0.24	0.41	0.34	0.28	0.43	0.32	0.29	*	0.34	0.28	0.32	0.28	0.14	0.21	0.25		0.14			0.19	0.26	Performance Date
	TEMP	(oF)	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	20	70		70	150	150	150	150		150	150	- T	150	150	4.
	MOTOR	NO.	8	10	11	13	14	15	16	17	18	19	3	7	9	12	1	2	5	7	6	8	2	22	23	24	TABLE
	_						_		_			_		_		_		_		_	_	_	_		_		

* Data lost due to instrumentation failure.

KEY FOR TABLE 5

The statistical data in Table 5 was calculated using the following definitions and formulas:

 $\overline{\mathbf{X}}_{\mathbf{n}}$ is the average value of the samples used.

 \bar{X} is the estimated average range of the represented population.

on is the standard deviation of the sample group

 $\boldsymbol{\sigma}^{\text{!}}$ is the estimated standard deviation of the represented population.

S.E. is the standard error of the mean which is used for determination of the range of average values to be expected for the represented copulation.

Xi Maximum and Minimum are the maximum and minimum individual values which are expected for represented population.

o' is calculated from the following formula:

$$\sigma' = \sigma_n \sqrt{\frac{n}{n-1}}$$

S.E. is calculated from: S.E. = $\sqrt{\frac{\sigma'}{n}}$

To obtain \overline{X}^{\dagger} values, the following was used:

$$\bar{\mathbf{X}}' = \bar{\mathbf{X}}_n + 2 \text{ S.E.}$$

Xi maximum and minimum values were calculated by:

Xi Max & Min = 2 (
$$\sigma' + S.E.$$
)

All statistical calculation was accomplished at the 95 per cent confidence level.

	TEMP	QUANTITY OF	\overline{x}_n	on	-	Xi	
PARAMETER	(°F)	SAMPLES	••	111	S.E.	HI CH	LOW
Duration (sec)	-75	10	18.58	.098	.033	18.85	18.31
	70	3	13.96	.178	.126	14.65	13.27
	150	10	10.89	.263	.088	11.62	10.16
Pressure (psi)	-75 150	10 10	416 7 3 4	3.7 18.9	1.2	426 786	405 681
Thrust (lbs)	-75	10	737	11.3	3.8	769	706
	70	3	1031	13.8	10.4	1088	974
	150	10	1348	36.5	12.2	1449	1247
Total Impulse (Lb.Sec)	-75	10	13716	180	60	14214	13218
	70	3	14393	27	19	14497	14289
	150	10	14677	132	44	15043	14311

TABLE 5. Statistical Evaluation of Data.

CONCLUSIONS

- 1. 15-KS-1000 Rocket Motors of age 10 years or less will perform within specification limits when subjected to temperatures now lower than $-65^{\circ}F$ or higher than $140^{\circ}F$.
- 2. The 15-KS-1000 units exhibit excellent resistance to damage caused by thermal shock or rough handling.
- 3. 15-KS-1000 Rocket Motors have a reliability of 99% at a 95% Confidence Level.

RECOMMENDATIONS

- 1. Recommend that the operational shelf life of the 15-KS-1000 Rocket Motors be extended to 10 years.
- 2. Recommend that tests be conducted annually to attempt further extension of the shelf life of this motor.

DISTRIBUTION LIST

3 Dep IG for Safety, Hq USAF (AFIGS-3), Norton AFB, Calif 1 Hq USAF (AFSSS-AE), Wash 25, DC 2 AFLC (MCSW and MCAS), Wright-Patterson AFB, Ohio AUL, Maxwell AFB, Ala 20 ASTIA (TISIA-2), Arlington Hall Stn, Arlington 12, Va Bureau of Naval Wpns (Code RMMO-5), Dep of the Navy, Wash 25,DC CO, US Army Mtel Comd Field Safety Agcy, Charlestown, Ind Safety Div (AMCAD-SA), US Army Mtel Cemd, Wash 25, DC US Army Ammunition Procurement and Sup Agey (SMUAP-Q), Joliet, Ill Hq AFSC (SCMMS-3), Andrews AFB, Wash 25, DC CO, Picatinny Arsenal (Tech Info Lib), Dover, NJ MATS (MAMSS/SBG), Scott AFB, Ill Tech Lib (Code T2), US Naval Propellant Plant, Indian Head, Md 10 00AMA (1-00Y, 1-00YIT, 1-00YID, 1-00YS, 1-00YEO, 5-00YEG, 1-00AEP) Hill AFB, Utah TAC (Dir of Requirements), Langley AFB, Va SAC (DM4E), Offutt AFB, Nebr ADC (ADMME-EC), Ent AFB, Colo ATC (ATMSS-CA), Randolph AFB, Tex CONAC (MSS-2WM), Robins AFB, Ga USAFE (MMD-H), APO 633, New York, NY 3 PACAF (PFORQ, PFNSS-W, PFMME-WSA), APO 953, San Francisco, Calif AAC(ALDMS-1), APO 942, Seattle, Wash NGB, Air Sys & Log Div (NG-AFSS), Wash 25, DC CO (QE Lab), US Naval Weapons Stn, Seal Beach, Calif CO (QE Lab), Naval Ammunition Depot, Concord, Calif Comdr. US Naval Ord Test Stn (Code 556), China Lake, Calif CO, US Naval Ammunition Depot (Code 35), Crane, Ind Det 4, ASD (ASQWW), Eglin AFB, Fla AFSC Engineering Office (ASNPESD), Hill AFB, Utah Dep IG for Safety, Hq USAF (AFIMS-2), Norton AFB, Calif 6593d Test Gp (Devel)(DGSMS), Edwards, Calif 1 Allegany Bellistics Lab (Tech Lib), P 0 Box 210, Cumberland, Md 3 Cml Projection Agey, John Hookins Univ, Applied Physics Lab,

(Attn: P.J. Martin, Asst Gp Suprv), 8621 Georgia Ave, Sliver

Spring, Md

ON LA ISSVILLIO	1. Robert M. Cavett I. Bobert M. Cavett	DINCLASSIFFE	UNCLASSIFIED	1. Robert M. Garett	UNCLASSI FI ED
ar	SIGNSTA ALTERNITIONS VING (COMMA), HILL AIR PORCE Rase, Utch GREEF LIFF IEST OR ROCKET WATORS, 15-26-1000, ME 6 WIDE, DY Robert M. GREEF, LIFF IEST OR ROCKET WATORS, 15-26-1000, ME 6 WIDE, DY ROCKET (OUT-TR-63-4) This investigation was one phase of a series established to determine the ulimate life of the 15-18-1000 Rocket Wetor. To encomplish this sever establishes of Hill laft Porce Base, Utch. In order to best eventuate serior facilities at Hill laft Porce Base, Utch. In order to best eventuate serior facilities at Hill laft Rocket Base, Utch. In order to best eventuate serior facilities at Hill laft Rocket Base, Utch. In order with this constant to be the serior series and the serior was an observation of the series of the serie		OF .	SHEP LIFE TEST OR ROCKEN WITH AIR PRICE Base, Utch SHEP LIFE TEST OR ROCKEN WORNEY, PLEA-1000, WH 6 MOINS, DY Robert M. CAWAL, MAN E MOINS, DY Robert M. CAWAL, MAN HE MOINS, DY ROCKEN, DO GOOGRAPH MAN HE WAS AN HEAVEN OF A SETTING REPORT. This investigation was one phase of a series established to determine the ultimate life of the 1748-1000 Robet Moiors. To scoomslike this, motors were visually and radiographically inspected and fired using statis facilities at Hill laft Porce Base, Utch. In order to best wall-ust services builty, toward the specifications limits was acceptibated at both high and low extremes of 150°P and -75°P. The motors, as in the past, continued to force the specifications limits was noted but was not significantly destinanted to effect services billity. The previous established life of 9 years was confirmed and an extension to 10 years is recommended.	
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Q*	SECTION INTERTITY OF COMMENT OF STATES AND S		AD	2705th Airmanitions Wing (100Mul), Hill Air Porce Base, Utah SHER' LIET IEEE OR BOOKET WOUNDE, 15-25-1000, MG 6 NOOS, by Babert M. Gravit, Patrary 1969, 27p incl. figures and tables. (OUT-Th-63-4) This investigation was one phase of a saries established to determine the ultimate life of the 15-25-1000 Nebet Neter. To eccomplish this, motors were visually and rediographically images de and first unit are serviceshilly, temperature conditionally desirates at Mill Air Porce Base, With. In order to best small ust serviceshilly, temperature conditional which as soonmality, temperature conditional was secondlished at both high and low extremes of 1967 and -795°. The motors as in the part, continued to function without incident. Some small after of the date from normality destinated to effect serviceshility. The previous established life of 9 years was confirmed and an extension to 10 years in recommended.	

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